DESIGN OF RCC STRUCTURES
(CIVL 3105)

Time Allotted : 3 hrs   **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

N.B. Students may consult Data Sheets available with Invigilators.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

  (i) For Fe 415 steel, permissible tensile stress in working stress method is
    (a) $250 N/mm^2$ (b) $150 N/mm^2$
    (c) $230 N/mm^2$ (d) $200 N/mm^2$

  (ii) For over-reinforced section
    (a) $x_u = x_{u\ max}$ (b) $x_u < x_{u\ max}$
    (c) $x_u > x_{u\ max}$ (d) None of the above.

  (iii) Minimum amount of tension reinforcement in a beam is
    (a) $0.55 bd/f_y$ (b) $0.85 bd/f_y$
    (c) $0.70 bd/f_y$ (d) $0.80 bd/f_y$.

  (iv) For a continuous beam, the ratio of effective span to effective depth of the beam should be less than
    (a) 10   (b) 30   (c) 20   (d) 26.

  (v) The anchorage value for 90° hook is
    (a) 12φ (b) 16φ (c) 15φ (d) 8φ.

  (vi) The maximum strain in concrete at the outermost fibre is
    (a) 0.002   (b) 0.003   (c) 0.0035   (d) 0.0025.

  (vii) The spacing of main bars in a slab shall not exceed
    (a) 200mm   (b) 500mm
    (c) 300mm   (d) 400mm.

  (viii) The maximum percentage of longitudinal steel in a column is
    (a) 6%   (b) 8%   (c) 5%   (d) 7%.

  (ix) Isolated footings are designed for
    (a) Bending moment   (b) One-way Shear
    (c) Two-way shear   (d) All of the above.

  (x) As per IS codal provisions, critical section for two way shear is taken as
    (a) Face of the column
    (b) Effective depth from the face of column
    (c) Half the effective depth from the face of the column
    (d) None of the above.

Group – B

2.   (i) State the assumptions of limit state of collapse (Flexure).
    (ii) Differentiate between working stress method and limit state method.
    (iii) Explain the stress-strain relationship for concrete and steel in limit state method of design.
    (iv) Differentiate between balanced, under-reinforced and over-reinforced section.

                                       4 × 3 = 12

3. (a) A simply supported RCC beam having 250mm width and 400mm effective depth is carrying a uniformly distributed load of 16kN/m. The beam is reinforced with 4 bars of 20mm diameter. The clear span of the beam is 4m. Design the shear reinforcement. Use M20 grade of concrete and Fe415 grade of steel.

   (b) An R.C.C beam of cross-section 250mm x 500mm has a clear span of 5.5m. The beam has 2 - 20mm diameter bars going into the support. Factored shear force is 140kN. Check for development length if Fe415 grade of steel and M20 grade of concrete is used.

                                       7 + 5 = 12

Group – C

4. (a) Determine the moment of resistance of a beam of dimension 250mm x 350mm. The area of tension steel consists of 3 bars of 16mm diameter and compression steel of 3 bars of 12mm diameter with the effective cover of 40mm. Use M20 grade of concrete and Fe415 grade of steel.

   (b) An isolated simply supported T-beam has a flange width of 2400mm and flange thickness of 120mm. The effective span of beam is 3.6m.

The effective depth of beam is 580mm and its width 300mm. It is reinforced with 8-20mm diameter Fe415 bars. Determine the moment of resistance of the section. Use M20 concrete.

5 + 7 = 12

5. (a) Design a simply supported roof slab for a room 7.5m x 3.5m clear in size. The slab is carrying an imposed load of 5kN/m². Use M20 grade of concrete and Fe415 grade of steel.

   (b) Write the steps to follow for the design of two way slab.

10 + 2 = 12

Group – D

6. Design a dog-legged stair-case for an office building given the following data:
   • Height between floor=3.2m
   • Riser=160mm, tread =270mm
   • Width of flight=Landing width=1.25m
   • Live load=5kN/m²
   • Load for floor finishes=0.6kN/m²
   Assume the stairs to be supported on 230mm thick masonry walls at the outer edges of the landing parallel to risers. Use M20 concrete and Fe415 steel. Assume mild exposure condition.

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7. (a) A short column 400mm x 400mm is reinforced with 4-25mm diameter bars. Find the ultimate load carrying capacity of the columns. Use M20 grade of concrete and Fe415 grade of steel. Assume e<0.05D.

   (b) Design a bi-axial eccentrically loaded braced rectangular column for the following data:
   Ultimate axial load P_u = 2000kN
   Ultimate bi-axial moment M_{ux} = 250kN-m, M_{uy} = 150 kN-m
   Unsupported length L = 3.5m
   Column section: B = 400mm
                          D = 600mm
   Grade of concrete: M25
   Grade of steel: Fe415

5 + 7 = 12

Group – E

8. Design an isolated footing of uniform thickness of a RC column bearing a vertical load of 600kN and having a base size of 500mm x 500mm. The safe bearing capacity of soil may be taken as 120kN/m². Use M20 concrete and Fe415 steel.

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9. Design Pre-cast pile to carry a R.C.C column with axial load 1300kN.
   • Uniaxial moment = 80kN-m
   • Shear Force = 75kN
   Field investigation data:
   • Soil = medium sand
   • Angle of repose φ =30˚
   • K = 1.25
   • Unit weight γ = 19.5kN/m³
   • Permanent surcharge q_0 = 24kN/m²
   Use M20 concrete and Fe 415 steel.

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